SECTION 2

FORMS

2-1 CONSTRUCTION

2-1.1 TYPES AND CONSTRUCTION DETAILS (Standard Specification 51-1.05)

1. Stay-in-place or lost-deck forming

The most common stay in place forms are "lost deck forms" used for box girder construction. Although there are variations in forming methods and construction details, the general system of forming a typical box girder bridge is shown at the end of this section. Low velocity powder driven nails used to attach wood ledgers to concrete in lost deck forming systems have been recently approved for use. (Appendix 2)

Lost-deck- sheathing can be an exterior or interior grade plywood, or particle board (large chip). Metal is sometimes used for corner and fillet forms or as reinforcement. Metal and precast concrete stay-in place forms, some having a structural significance in the final product, have been permitted on some projects (usually detailed on the contract plans or by CCO).

2. Exposed surface forms

In deck construction this would include the soffit forms for slab bridges, the deck forms for T-beam, steel and precast concrete girder bridges and the deck slab overhang for all bridge types. Soffit forms for slab bridges being comprised of plywood sheeting attached directly to and supported by the falsework joists or stringers are usually considered an integral part of the falsework system. (Falsework Manual)

Deck slab forms for T-beam, steel and precast concrete girder bridges and overhangs are usually of conventional plywood and joist construction. The method of supporting the forms is usually dictated by the type of superstructure. Although there are deviations and refinements, the forming systems shown at the end of this section illustrate the basic methods used for each type.

2-1.2 STRUCTURAL ADEQUACY

The adequacy of all deck forming systems must be checked by stress analysis;[1] however,- form behavior cannot always be predicted or determined by analytical proof of its load carrying capacity. Theoretical deflections can be calculated if the physical properties and condition of the material are known, but in the case of "lost deck forms", the sheathing is frequently a material or grade of material whose modulus of elasticity is questionable particularly when the moisture content approaches the saturation point.[2] Consequently, deflections may and probably do exceed some arbitrary value commonly accepted and known as a "negligible amount".

There is also evidence that deflections and settlement of

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[1] Standard Specifications Section 51-1.06A "The support for form panels supporting concrete deck slabs and overhangs on girder bridges shall also be considered to be falseworks and designed as such."

[2] Standard Specifications Section 51-1.05 exempts forms which are completely enclosed from the requirements for formed surface deflections or undulations. Section 51-1.06A considers only joists for deck slabs and overhangs as falsework. Refer to (1)

the forms is not instantaneous but continues, in some cases, during the initial set period of the concrete.

What effect, if any, concrete shrinkage has on prolonged form deflection and settlement is debatable. The important point is that deflection and settlement can and do occur after concrete placement. Normally, yielding of the forms is not structurally detrimental to the deck slab as long as it does not continue after the initial set period. Attaining a uniform riding surface may be impaired if the concrete subsides after form deflection and settlement.

The joists supporting the deck slabs of steel and precast concrete girder bridges and deck overhangs are considered as falsework and the sheathing deflections or undulations between joists, constituting forms for exposed concrete surfaces, are covered by the Standard Specifications.

The structural adequacy and deflection of timber joists can be determined by stress analysis. Patented joists should be load tested to determine the dead load deflection for the actual condition of loading if the manufacturer's loading data is in question.

Normally patented or timber joists for steel and precast concrete girder bridges are supported by ledgers which are either underpinned by posts to the bottom flanges of the girders or suspended from the girders by hangers. Custom or homemade hangers made of steel bar stock bent to form a "U" which fits over the top of the girders should only be used after they have

been satisfactorily load tested.

This method of fabrication induces high stress points at the bends, and use of this type of hanger has resulted in total failure under relatively light loads.

Many types of patented hangers are available for deck forming systems on either steel or concrete girder bridges. The safe working loads recommended by most manufacturers are based on and are subject to certain conditions and any modification of the units themselves or deviation from their intended use will effect their capacity.

One common stipulation is that the hanger bolts be either flush with or a specified distance from the edges of the girder flange. The rated capacity of some hangers may also depend on whether they are used on steel or concrete girders. Hangers must be investigated for potential uplift and subsequent rotation due to unbalanced loading.

Restraint may be provided by the forming system or the hangers may be welded to the girders subject to the conditional requirements set forth in the Standard Specifications.[3] On conventional steel girder bridges, restraint is provided by the extension of the haunch or deck forms under the girder flanges.

Overhang forms for box girder, T-beam and slab bridges are

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[3] Standard Specifications Section 50-1.05 Whenever electric welding is performed on or near members containing prestressing steel, the welding ground shall be attached directly to the steel being welded." Section 55-3.17 "Brackets, clips, or other material shall not be welded to the flanges of girders, unless shown on the working drawings specified in Section 55-1.02, "Drawings", and approved by the Engineer.

usually supported directly by the falsework system by underpinning with posts to the soffit forms.

On steel and precast concrete girder bridges the forms are supported by overhang brackets or jacks attached to the exterior girders.[4] Either system is considered falsework and analyzed as such.

Deflection and settlement must be minimal for appearance and satisfactory grade control when screeds are located in the overhang area. Determination of deflection and settlement is difficult, particularly when bracket or jacks with cantilevered joists or outriggers are used. A load test would be justified if form behavior and subsequent deflection and settlement cannot be. ascertained by stress analysis or precedent.

Patented overhang brackets and jacks, such as those manufactured by Superior Concrete Accessories, Inc., Waco Scaffold and Shoring Company and Burke Concrete Accessories, Inc., are in general use. Design information, including deflection data, for these units is available from the manufacturer and should be requested from the Contractor to check these products for contract compliance.

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[4] Standard Specification Section 55-1.05 "Falsework and forms supporting the concrete work on steel structures shall be constructed so that any loads applied to girder webs shall be applied within 6 inches of a flange or stiffener and shall be distributed in a manner that will not produce local distortion of the web. Temporary ties and struts shall be provided as necessary to resist lateral loads applied to the girder flanges and to prevent appreciable relative vertical movement between the edge of deck form and the adjacent steel girder."

2-1.3 VERTICAL ALIGNMENT AND GRADING

This is another area where good preconstruction planning will pay off. A discussion with the Contractor should determine the proposed framing system, types of material to be used, whether screeds will be located on the edge of deck forms, and how the forms will be adjusted. You should also discuss your grading requirements and procedures at this time.

Control for lost deck forms in box girder bridges is usually established the next working day after the soffit and stem pour. Deck grades should not be established in the field until adequate safety features have been installed.

Providing a cut from the top of a rebar dowel cast in the girders at predetermined points will give adequate control for deck forming. If cuts are given by the Engineer, all cuts should be to top of deck and then let the Contractor determine the elevations of form supports.

Grades should be provided at all breaks in grade and at intervals not closer than 8 feet longitudinally and 24 feet transversely to the centerline of bridge. The amount of vertical curve and camber must be considered when determining these intervals, so that string-lining between these points will not cut out camber or vertical curve. Refer to the Falsework Manual for more discussion on camber.

Rightafter deck grades have been established; a check should be made at random locations to see how these grades correlate with what is already poured.

Do the stirrup heights fit? (The length of the stirrup should have been checked before the stem pour). Is the structural depth correct? Now is the time to consider any necessary grade adjustments, not when you find out that the deck steel isn't quite right after it has been placed.

Grade for the deck overhangs will require extra attention since these grades. produce one of the more obvious lines of the structure. First, all grades should be picked at the locations where the grade adjustment is to be made. This means field measuring the locations of the overhang supports *and plotting these on the 4-scale drawing or edge of deck profile line. Before grading the overhangs, enough load should be on the forms to tighten up the joints. Usually this is accomplished when the major portion of the deck rebar is in place.

Many different schemes have been proposed for grading overhangs (i.e., grade every other support, grade it all l/4 inch low the first time then bring it up, etc.). Until you have proven the Contractor's system on your job, you should be prepared to check each location@ Your final check is the "eye ball, but make sure all final wedging and adjustments at the face of girders have been completed.

See Section 4 for a further discussion on grading overhangs.

2-1.4 HORIZONTAL ALIGNMENT

The horizontal alignment of the structure will generally dictate the tools necessary to provide this line. Before the

horizontal line is set on the edge of deck forms, the grade of these forms must be close. This rough grading can usually be accomplished by the Contractor with the use of templates and the lost deck grade dowels.

Straight lines are usually established with a transit and/or string line. Curved lines can be established with a transit and standard chord offset procedures using the centerline of abutments and bents as control points. On complex projects it would be wise to get District Surveys involved.

No matter what method of establishing line is used, always check the following two items:

1) check into known points at each end of the structure, and
2) check the overall width at several locations throughout the length of the-structure.

2-2 INSPECTION

(See Appendix 2 for Checklist)

2-2.1 STRUCTURAL ADEQUACY, MORTAR TIGHTNESS AND CONDITION OF SURFACE

Obviously, the structural adequacy of the forming system, as with falsework, is not determined solely on the basis of stress analysis. Inspection of the forms isnecessary to ensure their stability.

The inspection should preferably be made by personnel who are thoroughly familiar with the forming Plans (i.e., the person who checked the falsework or at least reviewed it).

The importance of mortar tightness and surface condition is apparent for the forms of exposed concrete surfaces where appearance is a factor. Because the lost deck is not visible, the subject of mortar tightness is often dismissed. Loss of mortar or grout through holes or cracks in the forms will not only affect the appearance of the concrete but also its structural quality. Tin is often used to patch holes or cracks and spray foam is useful especially around deck drains etc., as. long as there is solid backing. Note that building paper is not to be used to patch lost deck forms.

2-2.2 -DEPTH OF STRUCTURAL SECTIONS

Deck slab thickness, including the effective depth(s) and coverage of reinforcing steel, must be checked to insure structural adequacy. This is usually done by measuring from a string line pulled between the screeds or bulkheads prior to the finishing machine adjustment, and from the strike off or rollers of the finishing machine during the adjustment of the machine. The depths should again be checked during the pour by stabbing the plastic concrete following strike off. (A snap tie with the correct deck thickness marked on it is a good tool for this).

Effective depth and clearance of reinforcement is discussed in Section 3.

2-2.3 HINGES, CONSTRUCTION JOINTS, PAVING NOTCHES AND APPROACH SLABS

Forms or bulkheads for hinges, expansion and construction joints are set approximately 1/2 inch low to clear the rollers when a finishing machine is used, allowing it to "make" the grade at the joint. After final floating, a filler strip or edger board is attached to the form for dressing and edging the joint, or else the edge is sawcut later.

On multi-frame bridges connected by-a hinge, it is important to adjust grades so that the final surfaces match on either side of the hinge. Memo to Designers #11-34 Hinge Curl, is included in Appendix 2. After the first deck is poured it should be profiled and monitored, and from this information the grades of the second deck can be adjusted to match the first. Don't forget to include settlement in the second deck grades when trying to match the first. See the Inspection Check List in Appendix 2 for hinge monitoring procedures.

The top section of abutment backwall, formed between the expansion joint and paving notch, should not be constructed until the deck concrete is placed. The deck surface is then used to establish the finished plane for this section. Proposed approach slab grades (as well as entire bridge) on the 4-scale should be checked with the road "grid grades" when checking the 4-scale drawings. After the bridge deck is poured, the ends should be profiled so that adjustments can be made in the approach slab grades if necessary. Consult with District personnel so that both parties are aware of any proposed grade changes.

2-2.4 Overhangs

The importance of stability of deck overhang forming systems for aesthetic reasons and deck grade control was noted earlier. To avoid repetition, their inspection is included in Section 4 and in the Inspection Check List in Appendix 2.

2-2.5 Miscellaneous Items - Drains, conduit; etc.

All drains, conduit, etc., should be shown and identified on the 4-scale layout and grade sheet for each structure. It is a good idea to attach road plans and standard plans showing pertinent drainage, electrical and sign details to the bridge plans for reference.

Miscellaneous items must be checked for proper location and be adequately secured to prevent movement during concrete placement and finishing operations. Drains should be set low enough in accordance with the plans, and also the plane of the grate must be set parallel to the deck surface with the inlet properly sealed to prevent entrance of concrete and other foreign material.

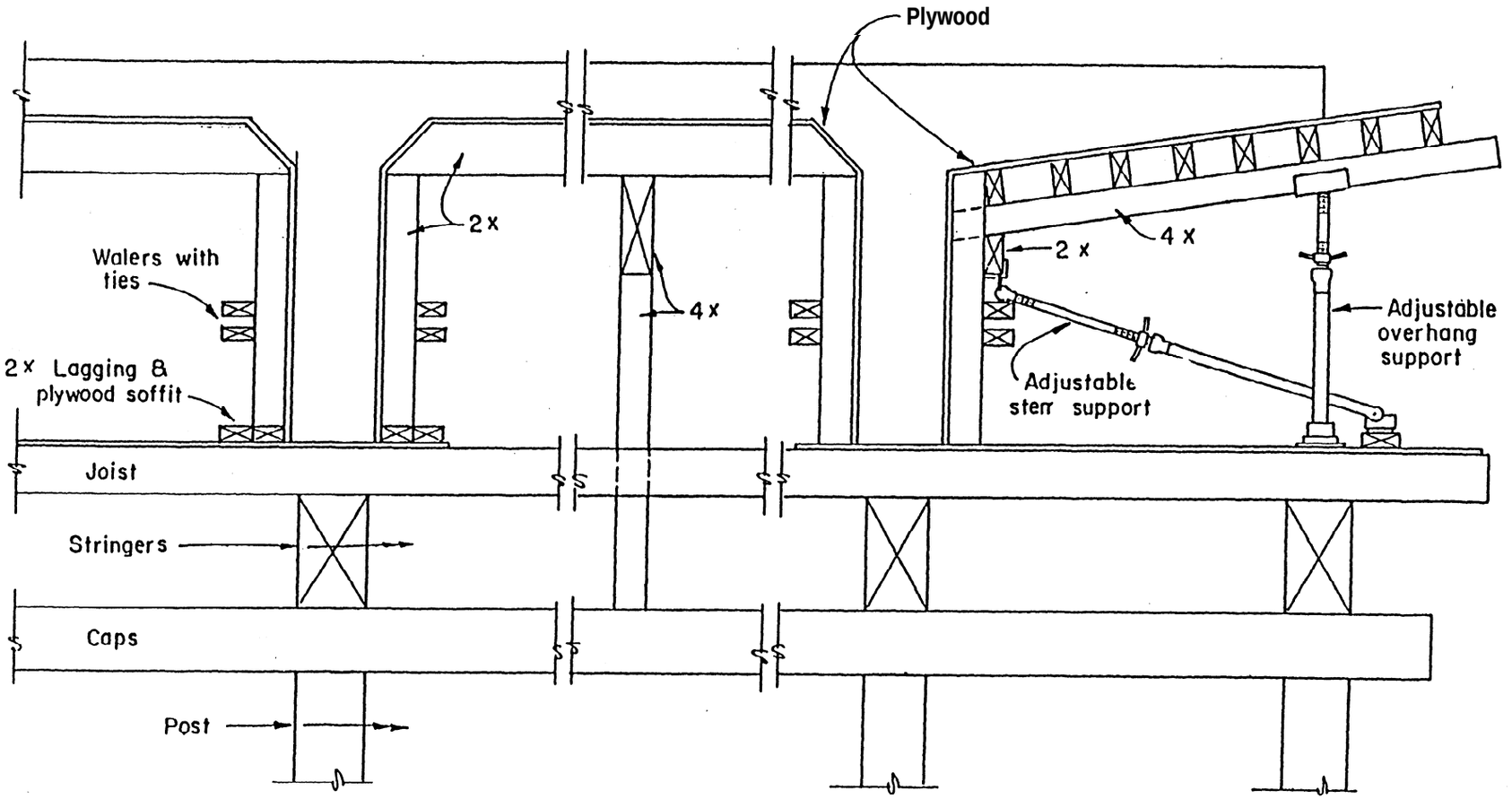
2-2.6 EXPANSION JOINTS (Standard Specification 51-1.12)

Joints to be sealed with Type A & B seals are sawcut at locations shown on the contract plans and to the dimensions determined in accordance with Bridge Records and Procedures 135-2.0.

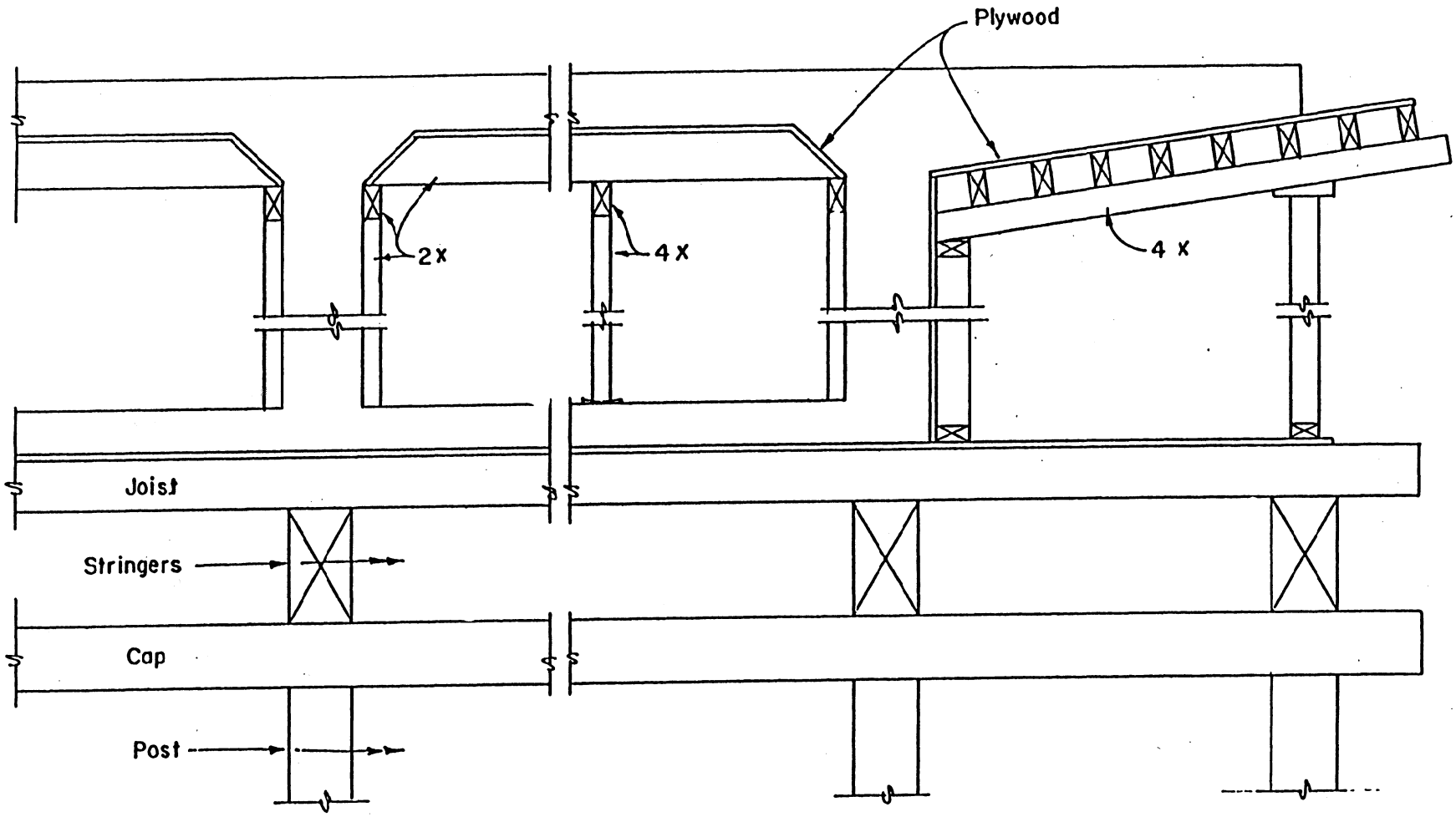
Joint seal assemblies are placed in blockouts between the deck and approach slab or in hinge sections, then concrete is deposited around the assembly. Shop drawings for joint seal assemblies should be submitted early for approval so that the required block-outs are formed to the correct dimensions, and the reinforcingsteel can be checked for proper clearance at these locations. These assemblies must be set to exact grade and carefully checked for their entire length. The assembly is sometimes warped or bent during fabrication by welding or the galvanizing process, in which case it should be straightened by reworking. Careful inspection should be given to skewed joints so that the assembly will fit properly at the barrier rail. See Bridge Construction Records and Procedures 135-2.0 for more discussion on joint seal assemblies.

Grinding should always be done prior to joint seal installation to avoid any damage to the joint seal or assembly. The Standard Specifications do not require deck grinding to be completed prior to the installation of Type A or B joint seals as it does for joint seal assemblies, but unless deck grinding is performed first you are only guessing at the correct depth of installation. The Contractor is responsible for any damage to the joint seal assembly and is responsible for constructing the completed roadway surface true to the required grade and cross section, including smoothness across the joint seal or assembly. Placing asphalt or concrete over a sand bed in the joint seal assembly block-outs prior to deck grinding is one method of achieving a smooth deck before installing the joint seal assembly.

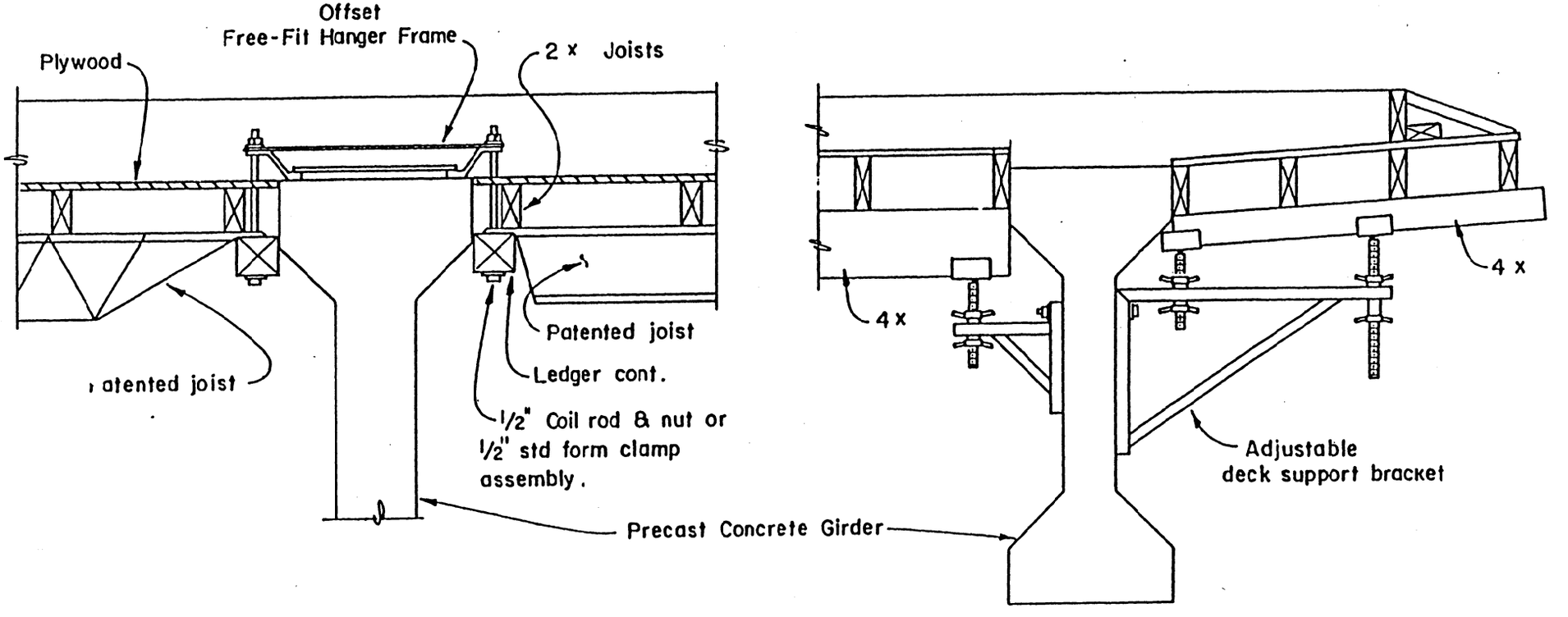
T-BEAM DECK AND OVERHANG FALSEWORK DETAILS



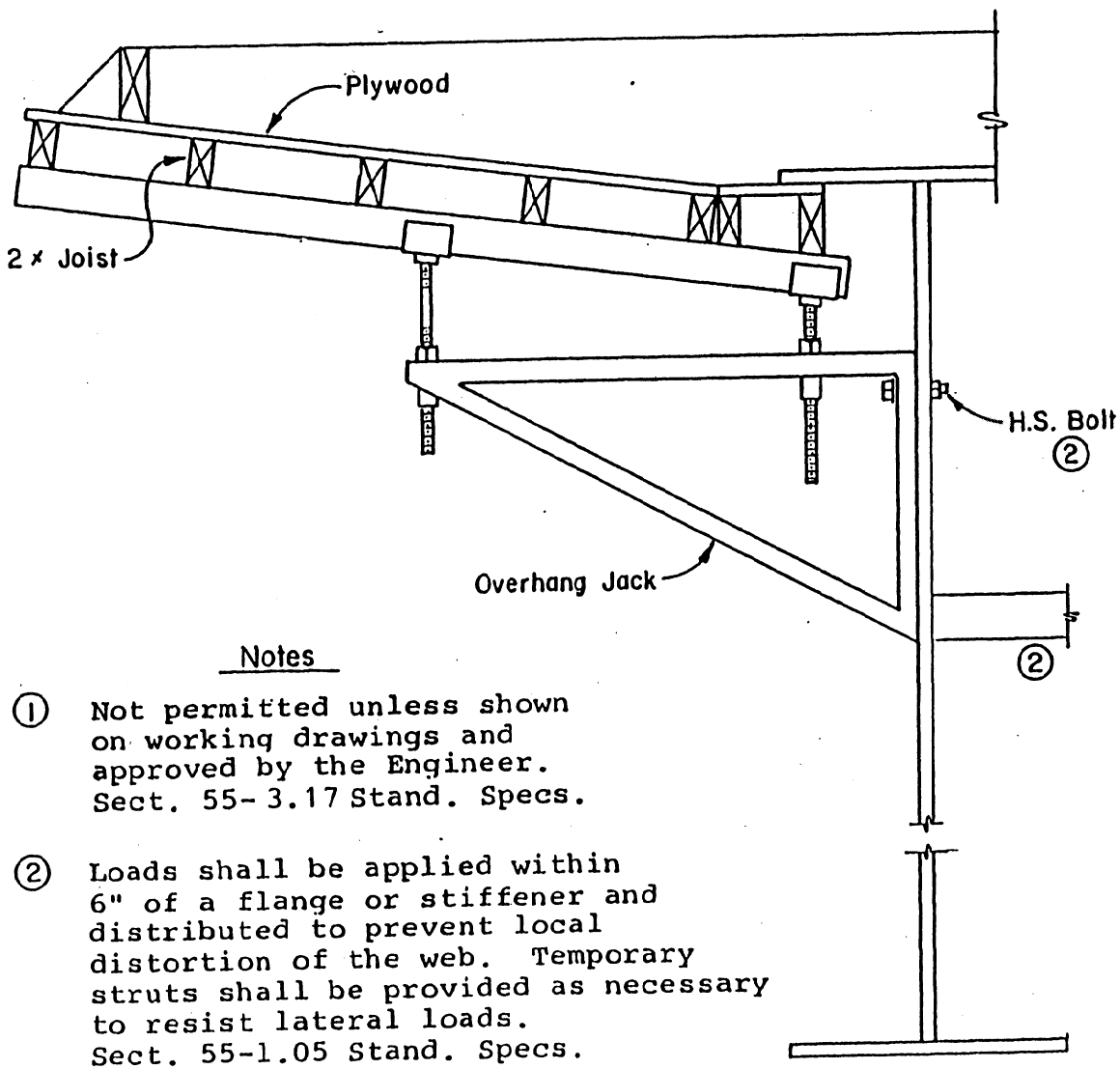
BOX GIRDER LOST DECK FORMS AND OVERHANG FALSEWORK DETAILS

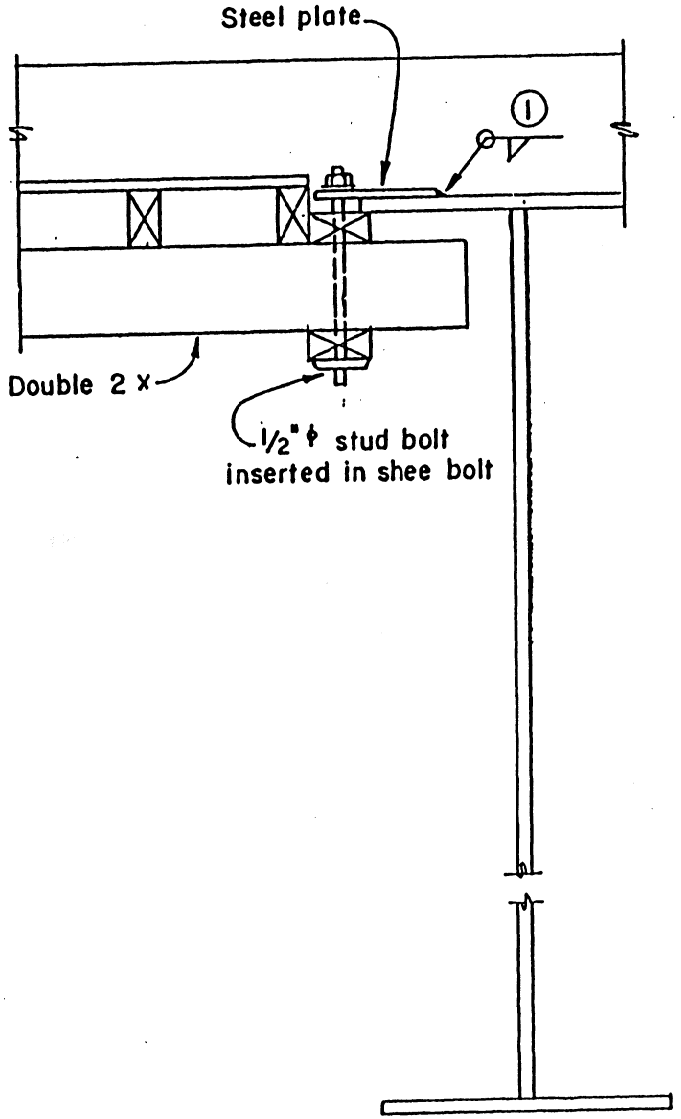


PRECAST CONCRETE GIRDER DECK AND OVERHANG FALSEWORK DETAILS



STEEL GIRDER FALSEWORK DETAILS



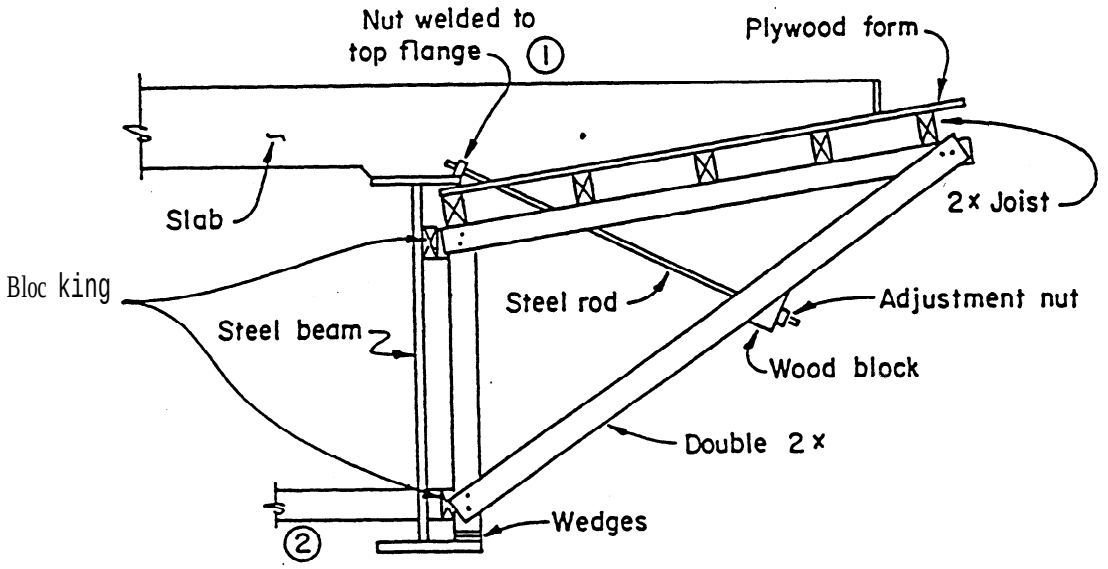


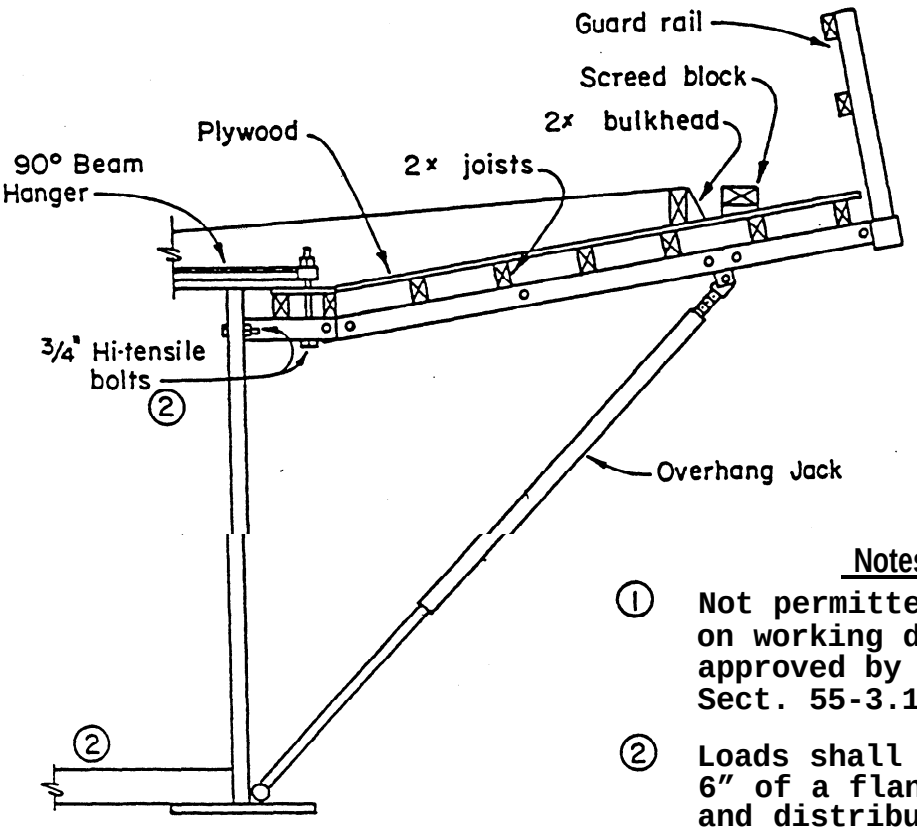
Notes

① Not permitted unless shown on working drawings and approved by the Engineer. Sect. 55-3.17 Stand. Specs.

② Loads shall be applied within 6" of a flange or stiffener and distributed to prevent local distortion of the web. Temporary struts shall be provided as necessary to resist lateral loads. Sect. 55-1.05 Stand. Specs.

DECK OVERHANG FALSEWORK DETAILS





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